DOCUMENT RESUME

ED 477 014 IR 021 742

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TITLE	SPLACH: A Computer Environment Supporting Distance Project-Based Learning.
PUB DATE	2002-06-00
NOTE	7p.; In: ED-MEDIA 2002 World Conference on Educational Multimedia, Hypermedia & Telecommunications. Proceedings (14th, Denver, Colorado, June 24-29, 2002); see IR 021 687. Figures contain illegible type.
AVAILABLE FROM	Association for the Advancement of Computing in Education (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588; e-mail: info@aace.org; Web site: http://www.aace.org/DL/.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Computer Assisted Instruction; Computer Software Development; *Distance Education; *Educational Technology; Instructional Material Evaluation; Instructional Materials; *Learning Activities; Learning Strategies; Secondary Schools

ABSTRACT

Describes research that deals with collaborative learning at a distance and takes place in the field of CSCL (Computer-Supported Collaborative Learning). To promote communications between people learning in a distance context, we think that it is important to involve these learners in collective activities. We suggest set-up activities using project-based learning to stimulate and facilitate collective learning. To support distance project-based learning, we designed and developed a computer environment called SPLACH. This environment comprises specific tools for different actors: the project designer, the learners and the project leader. SPLACH was investigated in two different contexts: with pupils in a secondary school in the domain of technology and with adult students learning programming at the Tele-university of Quebec. This article presents the computer environment SPLACH and some of the results of its evaluation. (Contains 12 references.) (Author/AEF)

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SPLACH: a Computer Environment Supporting Distance Project-Based Learning

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Abstract: Our research deals with collaborative learning at a distance and takes place in the field of CSCL (Computer-Supported Collaborative Learning). To promote communications between people learning in a distance context, we think that it is important to involve these learners in collective activities. We suggest to set-up activities using project-based learning in order to stimulate and facilitate collective learning. In order to support distance project-based learning, we designed and developed a computer environment called SPLACH. This environment comprises specific tools for different actors: the project designer, the learners and the project leader. SPLACH was investigated in two different contexts: with pupils in a secondary school in the domain of technology and with adult students learning programming at the Tele-university of Quebec. This article presents the computer environment SPLACH and some of the results of its evaluation.

Introduction and Context of Work

A major interest of computer-supported distance learning is to allow communication among students and to employ a constructivist approach for learning: according to the CSCL (Computer-Supported Collaborative Learning) research domain (Bannon 1989). Our main hypothesis is that conditions have to be created to stimulate interesting interactions between learners. A study of numerous distance learning environments made us realize that the main attention revolves around computer tools that must be provided for distant learners to communicate. Learners working together would theoretically need only communication tools. However, tools that simply offer technical possibilities for communication would appear to be insufficient to ensure collective learning. We feel this is not always sufficient. Indeed, although the learners are offered a possibility to communicate, there is no reason for them to do so if there is no common interest bringing them together. The lack of social cohesion renders truly collective learning impossible.

In order to create social cohesion in distance learning, our main concern is to concentrate on the instructional activity and to the computer environment to support collective learning. Thus, distance should not be seen as an obstacle to which the computer tools provide a solution, but rather as an interesting learning situation in which the computer tools are designed to support new learning activities. These were the principles governing the development of our distance collective activities based on project-based learning practices. Project-based learning (PBL) is an educational method of creating collective classroom learning situations which has been tried and tested for many years (Dewey 1902, Kilpatrick 1918, Johnson and Johnson 1991). It is particularly interesting to use in a distance learning context to encourage collective learning. However, existing distance learning platforms are not really suited to support PBL. Even if there are several experiments of PBL for platforms like WebCT or FirstClass (Christiansen and Dirckinck-Holmfeld 1995), these platforms distort the pedagogical situation (only tools to communicate and to exchange data, lack of tools for the teacher, lack of synchronous work tools, lack of group awareness tools, etc.). We stress the importance of two interdependent conditions for the success of distance PBL: (1) projects need to be set up carefully in order to promote interdependence in a distance learning situation (2) the computer environment has to support all the actors involved in PBL. In this way we decided to create a specific computer environment dedicated to PBL, founded on particular projects and team organization. The organization of each of our projects is structured around a *project designer*, role played by a teacher, a *project leader*, role played by a tutor, and a *team of learners* sharing tasks in the same project. The *project designer's role* is to define the projects by providing specification documents, structuring the projects and forming the teams, tasks usually pertaining to an instructional designer. The subject of each project should provide the learners with the opportunity to share tasks among themselves.

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Indeed, in a distance learning situation it is not advisable to make the learners collaborate all the time, that is to say carry out all the tasks together (Henri and Lundgren-Cayrol 2001). The project subject is presented as a list of tasks specifications, chosen so that it can be subdivided by the learners into separate parts which should, of course, not be independent from each other but, on the contrary, closely dependent. Moreover, in order to take into account the synchronous and asynchronous aspects of any distance work, the project is divided into stages where each stage is broken up into an asynchronous work phase followed by a synchronous phase. The intention of structuring collective work is to facilitate the learners' collective work and to stimulate the learning of how to work collectively. More information about the instructional design for the collective activities can be found in (George and Leroux 2001). The work of the *project leader* consists in monitoring the evolution of the project and helping the learners both technically and pedagogically. The project leader is seen as the facilitator and consultant. The *teams of learners* work to reach the goal set for the project. Each team was composed of three learners in order to promote high involvement in the project (Caplow 1968). In this paper, we focus on characteristics of the computer environment enhancing collective project-based learning (PBL).

Development of a Computer Environment to Support Distance Project-Based Learning

The main aim of our work is to provide tools for the different actors involved in project-based learning. The actors defined in the previous section should have computer environments allowing them to do their specific tasks: setting-up the projects for the project designer, carrying out the project in team for the learners and monitoring and intervening for the project leader. So the SPLACH [1] environment was developed to support PBL; it includes three computer environments which is customized for each of the actors, that is the project designer, the project leader and the learner. SPLACH is entirely developed in Java and is built on a client/server architecture (George 2001). We use the Java Shared Data Toolkit (JSDT) library for the data exchange between applications (Burridge 1999). We describe thereafter the three specific SPLACH environments.

Project Designer's Environment

With SPLACH, the project designer has tools to define and to set-up projects for learners. Firstly, the project designer can create new projects and specify teams of learners and their project leader who will monitor the learners. Then, the project designer structures each project in steps according to the pedagogical objectives to be reached. The project designer defines preformatted documents that will appear as a project progresses. Finally, the project designer plans project giving a preliminary schedule that could be discussed among the learners and their project leader (Fig. 1). Indeed this environment can be viewed as a project editor facilitating the creation of project-based learning in a distance context.

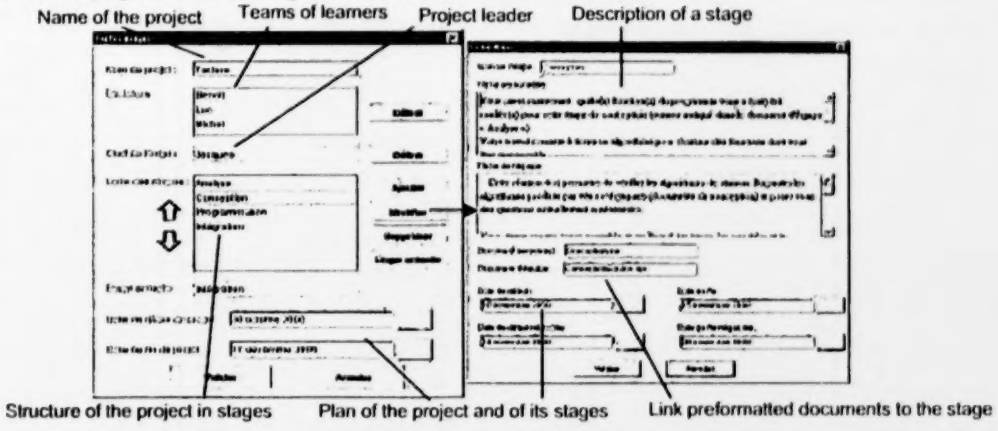
Name of the project
Teams of learners
Project leader
Description of a stage
Structure of the project in stages
Plan of the project and of its stages
Link preformatted documents to the stage

Figure 1: Interface of the project designer

[1] SPLACH is the French acronym for "*Support d'une pédagogie de Projet pour L'Apprentissage Collectif Humain*" which can be translated as "Support Project-Based Learning for Collective Human Learning".

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Learner's Environment

Concerning the learner's environment, our aim was to design an environment that incorporates all the tools necessary for the learners' collective activities. While common practice dictates the use of different tools (for instance Word® for editing documents, Eudora® for E-mailing and Netmeeting® for synchronous meetings) when learners have to use numerous software products at the same time, the cognitive workload will be increased. In a learning context, this extra load would not be favorable. The simpler the interface and use of the tools, the more learners will be able to concentrate on their activities. This simplicity calls for an environment comprising all the necessary tools to be designed and available in one environment. The amount of time and energy spent on the development will of course be greater, but this is the only way to develop a system that any learner can use, irrespective of his/her competence in computing. Moreover, there is another advantage to this investment. Existing software is often quite prohibitive, and difficult to analyze in terms of usage traces. Another of our aims was to facilitate collective learning based on information obtained from the computer system. The design and development of our own tools allow for collection of data concerning the learners' and the teams activities. These data are then analyzed and used by the system to promote the collective activities (Després and George 2001).

Thus the learners' SPLACH environment integrates asynchronous communication tools (E-mail and discussion forum), a synchronous meeting tool which allows textual discussion and application sharing, a scheduling tool in the form of a team calendar which provides the learners with coordination of the project, a tool to write reports during the project (documents are preformatted by the project designer) and, finally, specific tools of the subject matter. These specific tools are the only part of SPLACH that varies from one subject matter to another. A lot of attention was particularly paid to the design of the synchronous meeting tool, intending to support awareness (Dourish and Bellotti 1992) among the participants of a synchronous distance meeting and to stimulate the teamwork. Since good quality multipoint videoconference tools are not yet accessible with standard networks, we chose to display photos of participants during the meeting sessions. Moreover, participants can share a document and work collectively on it using an easy visual system of turn taking (Fig. 2). During a meeting, participants communicate within a semi-structured interface that helps to keep threads of discussion visible.

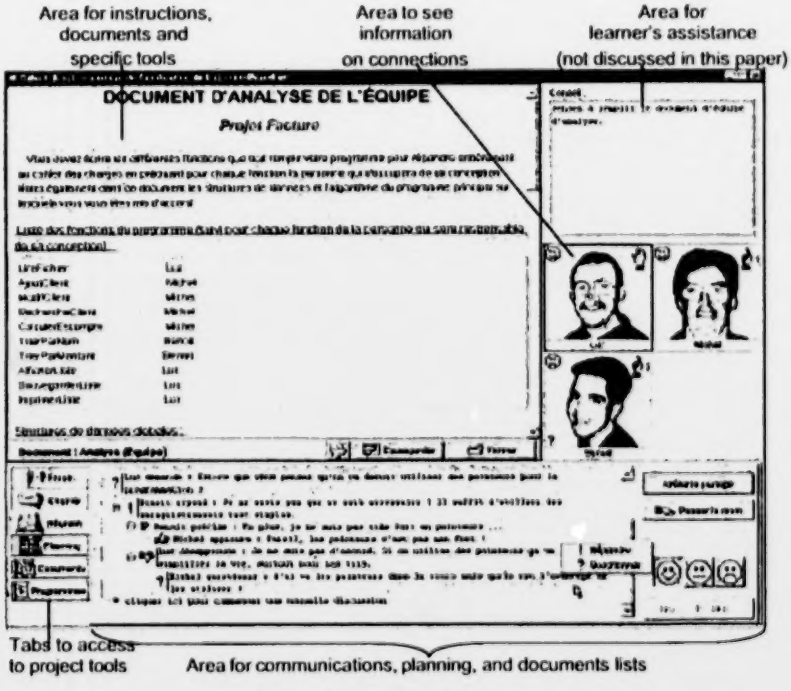
Area for instructions, documents and specific tools
Area to see information on connections
Area for learner's assistance (not discussed in this paper)
DOCUMENT D'ANALYSE DE L'ÉQUIPE
Projet Facture
Tabs to access to project tools
Area for communications, planning, and documents lists

Figure 2: Interface of the learners

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Project Leader's Environment

The project leader is a central key in our conception of distance PBL. S/He has to have tools to communicate with learners and to monitor their activities. For the moment, the project leader's environment is very close to the learner's environment; however including some additional functionalities and specific rights. Thus, the project leader can modify the planning of a project, manages rights of turn taking during synchronous meeting. We are presently researching and investigating specific tools to assist the tutor in monitoring both individual and collective learner activities. To reach our objectives to refine the leader/tutor environment, an iterative design process is employed by implementing the SPLACH environment, interview and keep traces of how tutors use it, and then adapt and enrich the SPLACH environment accordingly. One of these tools is a system designed to assist the tutor in his monitoring tasks (George 2001).

Evaluation of SPLACH

One of our major concerns was to develop a computer environment, which can support projects in a large range of educational fields. In order to prove the reusability, SPLACH has been investigated in two different contexts: with junior high school students in the technology field and with adult students learning programming. In the following sections, we discuss some results focusing on the use of SPLACH. These results are based on observations, questionnaires and automatic data traces recorded by the computer system.

With Junior High School Students in Educational Robotics

Each year a robotics competition is organized for junior high school students in the department of the Sarthe (France). All teams taking part are given a list of specifications at the beginning of the school year; during the year the students work on designing robots in order to compete in the festival at the end of the school year. This festival provided an interesting situation to design the collective distance projects. The students on each team usually come from the same school. For our investigation, we created two teams made up of students from geographically remote schools. These teams of learners used our SPLACH environment from their classroom to work collectively on the robotics project. We assumed the role of project designer and project leader ourselves from our laboratory in order to better understand how it felt to supervise and monitor teams of learners at a distance. For these evaluation, we added specific tools from the educational robotics fields to SPLACH: a tool to view electronic course books that embed all notions introduced in the technological context, a tool to describe micro-robots [2] to computers which automatically generates elementary programs, and a tool to program and drive micro-robots. The Fig.3 shows screen shots of these different tools.

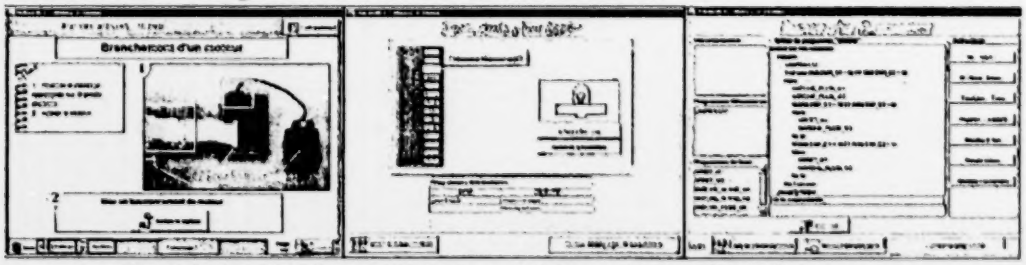

Figure 3: Specific educational robotics tools integrated in the SPLACH environment

The evaluation was conducted with fifteen students (aged 13/14) in three different schools. The list of specifications for this project, defined by the organizers of the robotics challenge, required the teams to design a robot which could carry out several functions (follow a black line, knock over a skittle, put a ball into a hole, etc...). The students defined the modules it would take to build a robot and then determined who was going to do what. Obviously, the modules were interrelated, which in turn promotes collective learning, since they depended on each other to bring the modules together as one robot, which would enter the competition.

[2] The robot used are Fischertechnik© micro-robots.

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The evaluation lasted for about three months, with the students using the SPLACH environment for about two or three hours each week. Every Friday lunchtime, ninety minutes were set aside for synchronous meeting sessions with the teammates. Outside these sessions the teams could work on the project whenever they wanted to by communicating asynchronously via Email or the discussion forum. Two weeks before the competition, the students met physically for the first time in order to assemble the different parts of the robots. On the day of the festival, one of our teams shared first place in the competition. The results of a post-questionnaire show how the learners felt the importance to work collectively, and that they found this type of collective work highly motivating. Moreover, the results of the questionnaire show that the learners perceived that they were part of a team throughout the project, which was also apparent during the competition. We can therefore say that our main educational goal, which was to create social cohesion and interdependence among distance learners, has been achieved. The learners had no particular difficulty to use SPLACH even if they were children. It was one of our concerns to make SPLACH so user-friendly that it would cater to a wide public of learners, including young ones.

With Adult Students Learning Programming

A second evaluation of SPLACH was carried out at the Tele-university of Quebec. Six adult students in a programming course used SPLACH during six weeks to work in teams, each student working from her/his own home. The list of specification of the projects corresponded to a practical work of their course. The main goal was to permit the students to work collectively on a program in Pascal, each student being responsible for specific functions of the program. A tutor at the Tele-university assumed the role of project leader.

We have integrated to SPLACH a specific tool to allow the learners to work in team on a same computer program. This tool makes a link between SPLACH and the Delphi® environment. Thus the computer functions and procedures found in a source program written with Delphi® are automatically added into SPLACH. In this way learners share their programs. The Fig. 4 shows this tool during the display of a programming procedure in SPLACH. In the lower part of the screen, the learners can access the main program, their personal programs or their teammates programs.

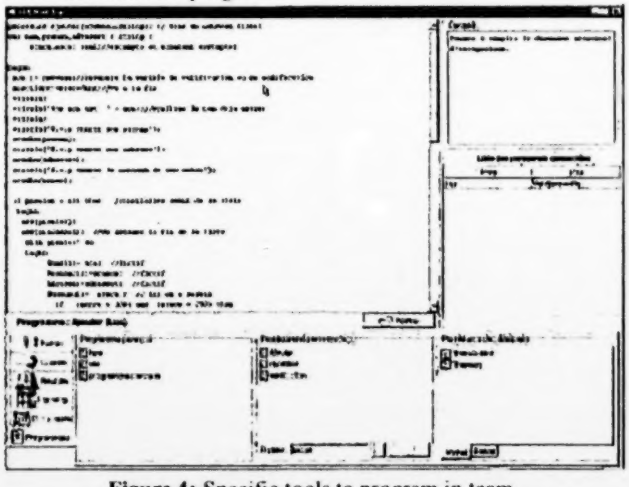

Figure 4: Specific tools to program in team

Altogether, students connected to the SPLACH server for a total of 70 hours. Students' answers to the questionnaire bring out the fact that they appreciated the possibility to communicate and to help each other. Furthermore, the students considered the synchronous phases to be necessary to the organization of the collective activity even if they place temporal constraints not always easy to solve. This type of project appears to help students better understand the necessary conditions to a good cooperation. They like the environment because it allows them to easily gather documents and programs together in the same place. Furthermore, they felt that the project leader had a crucial role, although some of them regretted that he was not more actively involved and more directive. Moreover, some of the students would like to take on the role of the project leader. It's an option that we foresee for future investigations.

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Outcomes From the Evaluations

For the two evaluations, the goal of the projects were reached: building and programming a robot for the junior high school students, writing a computer program for the students of the Tele-university. An observation of the students' activities shows that final products have really been the result of collective work. These evaluations also made it possible to substantiate the validity of the SPLACH environment from both a pedagogical and technical point of view. This environment is capable to adequately supporting distance project-based learning. The students found it easy to use, most likely because it integrates all the tools necessary for collective work. We have also shown that the SPLACH environment can be used in different context.

Conclusions and Futures Directions

The SPLACH environment was developed to support project-based learning at a distance. It adapts its tools according to the actors: the project designer, the learner and the project leader. For a distance learning designer, SPLACH can be seen as a computer platform facilitating the setting-up of project based-learning in which you only have to integrate the tools pertinent to the subject-matter. If existing specific tools are developed in the java language, they could easily be integrated to SPLACH. In other cases, a link can be made in SPLACH to launch external specific tools. For learners, a strong integration of the collective work tools leads to make SPLACH accessible to a wide public of learners as the evaluations corroborated. It was noticed from our evaluations that the project leader/tutor had a much more active role compared to traditional tutoring of individual distance learning. The collective activity is more complex to supervise and monitor, which is more time consuming for the tutor. Thus, a future direction of our work lies in providing particular tutor tools to assist her/him in the supervising and monitoring of learners' collective activities. In this way, we work on integrating a multi-agent system into SPLACH aiming at helping both the learners and the project leader.

Acknowledgements

The author would like to thank the France/Quebec cooperation commission for their support. It is realized inside the LEA project concerned by the tele-assistance in the context of practical work in technology. The LEA team is composed of researchers from the LIUM (France) and the LICEF (Quebec). The author wishes to express his gratitude to the schoolteachers, tutors and students for enabling him to carry out the evaluations in real-life situations. The author also wishes to thank Karin Lundgren-Cayrol for her helpful comments on an earlier version of this text.

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